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An IBM 1050 AV computer system, including a typewriter keyboard, tape recorder, and slides, was used to teach 4-year-olds word and letter recognition. Three studies explored sex differences in relation to differences in socioeconomic status and learning materials. In experiment 1, 16 disadvantaged children explored the keyboard individually for 6 sessions; then a matching task was presented. Eleven keys with words only were exposed. Experiment 2 expanded these procedures, with 20 disadvantaged children participating in 17 sessions. Ten of these subjects were exposed to letters only; 10, to words only. Boys scored significantly higher than girls on the matching task in experiments 1 and 2. No differences were found between word and letter programs. In experiment 3, 15 middle-class boys and girls participated in 10 exploratory sessions followed by a test. No sex differences were found for the middle-class children. However, the letter program was easier for them. The authors concluded that the computer system used did not react fast enough to hold the attention of the children but that a computer-assisted instructional approach which provides for gross motor responses in lieu of verbal ones is well-suited to disadvantaged children, especially boys. References are included. (CM)

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LEARNING TO RECOGNIZE WORDS AND LETTERS ON A CAI TERMINAL

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A few years ago we began to explore the usefulness of an IBM 1050 AV computer terminal for studying initial reading instruction.* This is a report of three brief studies we carried out with four year old children in the course of our explorations. Our data concern sex differences in relation to differences in socio-economic status and learning materials.

Initially we were planning a long term study of the last of these variables, i.e., we were planning a study relevant to "the great debate" (Chall, 1967). The machine seemed to offer a way to control teaching techniques hitherto impossible in research on teaching (Green, 1964). In the beginning we had rather extravagant ideas and hopes of what we could accomplish, but eventually we concluded that the particular machine system we were using (the 1050-1440)

*Thanks are due to the Kettering Foundation and the Field Foundation for their generous support of our work.

was not really well-suited to our purposes because it did not react fast enough to hold the attention of our children.

However, we must add that (a) CAI has great potential for studying instructional processes, (b) some systems, e.g., the IBM 1500 system, appear more suited to the sort of research we started, (c) much valuable research on instruction can be undertaken with the 1050-1440 system. Furthermore, our data suggest that mechanical arrangements of this sort are especially suited to disadvantaged youngsters.

Although we intend to elaborate on the relationship of behavior to the machine system in a later paper, a brief description of our arrangements and hardware and how we were using them may make these matters clearer as well as provide the necessary background for interpreting the results we obtained in the studies reported below.

Equipment and Materials

The 1050 AV looks externally like a typewriter on a desk and in fact can be used as a typewriter. It can send and receive information from the computer which can record, store, and transmit large amounts of information. In a CAI system this information can be learning materials, student responses, and instructor's directions about how these should be arranged. The material in this case was a word or letter for each key, plus the directions to print that word or letter and directions to the attached tape recorder and slide projector to play a certain section of the tape and show certain slides. The tape recorder and projector were inside the 1050 and the slide images appeared on a screen to the left of the keyboard.

The 1050 along with a chair for the child and a chair for the proctor were the only furnishings of the small room used. The room was carpeted and had full length drapes on three walls. The fourth wall had two doors and one-way mirror. The computer was at the Florida State University CAI center in Tallahassee several hundred miles away. We were connected by dataphone--a kind of telephone.

The system is arranged so that:

(1) Input to the computer is typed on the 1050.

(2) A signal called an EOB (end of block) is given the computer to receive this information and proceed as programmed--at this point the 1050 keyboard is locked and no more information can be put in; a light, the "proceed" light, is out during this state.

(3) The computer executes its instructions and any information or response programmed is typed out on the 1050, and/or slides are shown and/or taped messages are played.

(4) The proceed light comes on again and the 1050 is set to receive more information.

In our studies the children initiated the sequence whenever they pressed or struck a key on the keyboard. The proctor then used a remote button to send the EOB signal, whereupon by direction of the computer (a) the word corresponding to the key struck appeared on the screen in black and white print, (b) the tape recorder said the word twice, and then (c) a picture corresponding to the word was shown--if the word was not a concrete noun, an abstraction was shown (e.g., a

green circle with a yellow dot in the center was used with the word "here"). When letters rather than words were used, the "pictures" were abstract designs built around the letters. The word or letter was also pasted on the key. Sessions so arranged were called exploration sessions. Table 1 shows this sequence of machine and pupil activities.

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Insert Table 1 about here
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This sequence took from 5"-40" with a mode of about 15", which is just too slow for young children when both input and output are brief. Later in learning when the material transmitted is more substantial, this delay would be much less important. We should add that working over a telephone produces problems, e.g., thunderstorms anywhere between the terminal and computer can spoil transmission; also our carousel projector jammed often. Coupled with other breakdowns the result was an ineffective learning environment. The fact that the children learned anything is evidence that this sort of machine system--as opposed to this particular one--is conducive to learning among four year old deprived children.

To measure learning, the program was changed so that first the tape recorder said a word and the projector showed the word. The child was told to find the key for that word. If he struck the correct key, the machine said he was correct, showed the picture of the word, and presented another word. If he pushed an incorrect key, the machine either did nothing, or said "try again" and repeated the word. It is from this matching or recognition task that most of our data came.

Table 1

The Sequence of Events During a Child's Exploration of the Keyboard

Step	Event
1.	Child presses any exposed key.
2.	Proctor enters EOB.
3.	Proceed light goes off.
4.	Computer processes input and directs 1050 how to respond.
5.	Screen shows the word on the key that was pressed.
6.	Tape recorder says the word twice.
7.	Proceed light comes on.
8.	Sequence is repeated.

Typically the children came to the center in a small group of four to eight. Their first day they were shown the machine in a group and each had a turn to make it work while the others watched. After this initial orientation each child had a daily period of up to ten minutes to work the machine. Only the proctor sitting off and behind the child was in the room. The proctor said nothing. No child was required to do anything except leave the room after ten minutes. The children were free to leave early (but not return until the next day), to do a lot, to do a little, or to do nothing both during the exploration sessions and during test times. Our general style of procedure was based on that of O. K. Moore (1964), although our machine was a bit different.

While waiting their turn or transportation back to their school, the children played in an adjacent set of rooms or a playground under the supervision of a teacher.

Experiment I

The purpose of this experiment was to explore a machine variable that turned out to be irrelevant; however, some results of interest were obtained. On seven consecutive weekdays, 16 four and five year old children (eight Negro girls, seven Negro boys, and one Caucasian boy) were brought from a day care center to the CAI center for about two hours in groups of eight (four boys and four girls). The financial criteria for enrollment in the day care center made it clear that these children came from disadvantaged backgrounds.

All but eleven keys of the keyboard were masked as were all other features of the keyboard except the proceed light which was greatly enlarged and placed directly behind and above the keys at eye level (even so, most children ignored it at first). It was arranged that each key represented a word and the machine functioned as described above. The words used were eat, run, type, yes, fish, girl, here, cat, no, boy, dog.

The subjects followed a program of six exploratory sessions with a maximum length of ten minutes. On the seventh day after two minutes of exploration the matching task was presented.

Records were kept of all responses made by the subjects both during the exploration and during the matching (except responses made when the proceed light was out). The proctor also recorded impressions of the children's behavior.

Results

Some children explored the keyboard vigorously, some made few attempts; some keys were struck more often than others. Table 2 shows the data for each subject ordered by score on the matching task. There is a clear difference in favor of the boys on matching (Mann-Whitney $U=12$; $p<.02$). Both age and amount of activity during exploration are related to these scores ($rho=0.49$, $p<.05$ and $rho=0.47$, $p<.05$ respectively), but bear no very evident relation to each other ($rho=0.33$, $p>.05$).

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Insert Table 2 about here
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Table 2

Results of Experiment I

Subject Rank by Score	Sex	Age in Years	Activity Index	Test Score*
1	M	5.3	9.2	32.6
2	F	4.8	11.9	31.9
3	M	4.9	7.4	26.3
4	F	5.2	2.4	21.8
5	M	4.7	18.0	19.4
6	M	4.8	18.1	19.4
7	M	5.9	12.2	12.7
8	M	4.6	9.1	12.4
9	M	4.7	11.2	9.6
10	M	4.5	16.3	9.4
11	F	5.0	8.3	9.0
12	F	4.5	7.1	7.6
13	F	4.4	4.1	7.4
14	F	4.6	2.6	5.5
15	F	5.5	30.7	4.5
16	F	4.3	8.3	2.7
Mean	M	4.9	12.7	17.7
Mean	F	4.8	9.4	11.3
Mean	Total	4.9	11.1	14.5
Median	Total	4.8	10.2	11.0

* This score is based on number of trials to get the correct key--up to eleven trials were allowed. The score indicates the amount of information represented by the successful trial for each letter modified to allow for chance successes.

The sex difference interested us because it favored the boys who usually are the most disadvantaged in reading. We hypothesized that amount of activity was responsible, thinking perhaps the boys were really more active than the girls, although the difference was not significant. Age was not responsible since the differences in favor of the boys were minute (and can be eliminated entirely by removing the boy ranking seventh in the group without changing the score difference).

Although our attention was still focussed on other issues, our next study confirmed these results.

Experiment II

The subjects were 20 Negro children, 10 boys and 10 girls from a private day care center, the Non-Profit Day Care Center. The major purpose of the study was to check the procedural comparability and the feasibility of our operations with two sets of materials, words or letters.

The five boys and five girls in group W were treated exactly as those in Experiment I, except that 29 keys were exposed instead of 11. As before, each key was covered by a tab with a word printed on it. Group L, consisting of five boys and five girls, followed the same program except that each key represented a letter instead of a word. As Table 3 shows, most of the boys in both groups were older than the girls. The children were given a brief individual screening test to make sure that they were not already able to identify the words and letters.

The general procedures described previously were followed. There were 17 sessions in a six week period. Three of these were testing sessions: the seventh, the twelfth, and the seventeenth. The weekdays during which the children did not have turns at the machine were largely after the first test day. Since absences were frequent as well, their opportunities to learn after the second week were very scattered and progress was slight. It was at this point that we concluded that the machine system would not serve our original purpose.

During the testing sessions the subjects were given only five trials on the matching task (in contrast to 11 in Experiment I) before the proctor showed them the correct key. The rank scores obtained on the three tests show high correspondence ($W=.87$, $p<.01$) indicating substantial reliability of the measure and making it reasonable to use a mean of these scores for each child. The latter step was necessary because the frequent absences would otherwise make our data too incomplete for analysis.

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Results

The data confirm the previous result: boys score higher than girls ($U=9$, $p<.01$). These boys were also older than the girls, but an analysis of covariance controlling age led to rejection of the null hypothesis at $p<.05$. A comparison with the five oldest boys and five youngest girls eliminated (which reverses the difference in mean ages

Table 3

Results of Experiment II

Subject Rank by Score	Program	Sex	Age in Years	Mean Minutes Per Session	Mean Test Score
1	L	M	5.2	10	46.3
2	W	M	4.8	10	36.9
3	L	M	3.8	10	22.1
4	L	F	4.1	10	21.9
5	W	M	4.1	6	21.9
6	L	M	4.7	10	21.1
7	L	M	4.5	10	16.1
8	L	M	4.5	10	14.5
9	W	F	4.4	10	6.8
10	W	F	3.7	10	6.7
11	L	F	3.8	4	5.5
12	W	F	4.1	6	5.3
13	W	M	5.3	10	4.3
14	W	F	3.6	7	3.7
15	L	F	3.4	7	2.3
16	W	M	4.5	4	2.2
17	W	F	5.1	10	2.2
18	W	M	5.1	5	1.3
19	L	F	3.5	2	1.2
20	L	F	3.9	3	0.0
Mean	W	M	4.8	7.0	13.3
Mean	W	F	4.2	8.6	4.9
Mean	L	M	4.5	10.0	24.0
Mean	L	F	3.7	5.2	6.2
Mean	W	Total	4.5	7.8	9.1
Mean	L	Total	4.1	7.6	15.1
Mean	Total	M	4.6	8.5	18.7
Mean	Total	F	4.0	6.9	5.6
Mean	Total	Total	4.3	7.7	12.1
Median	Total	Total	4.2	10.0	6.1

of the remainder, making the girls older) still shows boys significantly better than girls on the matching task ($p<.05$). No differences between word and letter programs could be found. A 2 X 2 analysis of variance using sex and program as variables confirms these findings and showed the sex differences to be independent of program. The records also showed that the high scores were associated with longer average time per session (but not total time).

Experiment III

To complete this work and interpret the data collected, it seemed desirable to try our materials with privileged children. Accordingly, eight boys and seven girls (the eighth girl quit after three sessions) were brought daily (more or less) for 11 sessions during a three and a half week period in the summer. They were brought individually by a parent and usually (when the system was working properly) stayed only a few minutes before or after their appointment. Testing took place on the eleventh day. In other respects the procedure was unchanged.

Results

Table 4 shows the results for these children. Even though the girls had a small age advantage, they did not do better than the boys; no sex differences were found. However, the letter program was clearly easier for these children ($t=3.49$, $p<.01$). This group of children spent less time per session than did the preceding groups; the average

number of sessions attended was less than that for the April group (8 in contrast to 13) but the sessions were not as scattered.

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Insert Table 4 about here
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The scores obtained seemed in a similar range as those of the April study and so, for amusement, the data were combined in a 2 X 2 X 2 analysis of variance. To keep matters simple (i.e., to keep numbers equal) a "score" equal to the group mean was added to WF group. The program differences remained prominent, sex differences disappeared, and no SES or race differences were found. However, the program by SES and the sex by SES interactions approached standard levels of significance ($p<.10$).

Discussion

The analysis of variance just reported suggests the same things that a naive comparison of Experiments II and III suggests. It seems probable that the CAI system helps boys more than girls. Among the disadvantaged, boys did better than girls; and in the middle-class group the customary superiority of girls disappeared. The interaction of sex and socio-economic status indicates that this help is greater for disadvantaged boys than for privileged ones. Since even middle class boys are somewhat disadvantaged in the primary grades in comparison to girls, we conclude that there are features of a CAI approach especially suited to disadvantaged children. We believe it has to do with chances to make gross motor responses in lieu of verbal ones.

Table 4

Results of Experiment III

Subject Rank by Score	Program	Sex	Age in Years	Mean Minutes Per Session	Test Score
1	L	M	4.8	10	45.6
2	L	F	4.5	10	44.5
3	L	F	4.0	9	37.3
4	L	M	3.8	6	22.3
5	L	F	4.5	5	18.2
6	L	M	3.2	9	17.8
7	W	F	4.2	8	13.9
8	L	M	3.8	10	12.8
9	W	M	4.2	4	11.9
10	W	M	3.8	6	9.0
11	W	F	4.2	4	8.7
12	L	F	4.2	8	8.2
13	W	F	3.8	10	4.8
14	W	M	3.8	6	4.4
15	W	M	3.4	6	2.6
Mean	W	M	3.8	5.5	7.0
Mean	W	F	4.1	7.3	9.1
Mean	L	M	3.9	8.8	24.6
Mean	L	F	4.3	8.0	27.0
Mean	W	Total	3.9	6.3	7.9
Mean	L	Total	4.1	8.4	25.8
Mean	Total	M	3.8	7.1	15.8
Mean	Total	F	4.2	7.7	19.4
Mean	Total	Total	4.0	7.4	17.6
Median	Total	Total	4.0	7.1	17.6

Other interpretations are possible. For example, McNeill (1964) found that boys did better than girls "...after autoinstructional procedures that provided frequent and equal opportunities to respond and insured identical presentations of reading lessons to boys and girls (including words of praise)." Reading performances of these same children a year later in first grade classes reverted to the typical pattern of female superiority. McNeill rejected our sort of explanation in favor of a differential teacher treatment hypothesis. That teachers favor girls seems unquestionable but that does not explain a superior male performance with the machinery.

The program X SES interaction indicates that the results of the two studies were indeed different, and that the greater ease of matching letters than matching words is limited to the middle class group. From this we are happy to infer that some of the preconceptions we had when we started three years ago have some merit.

In the beginning of learning, words are visually more complex and harder to discriminate than letters; on the other hand meaning aids retention. Among privileged children, this latter variable plays less of a role than among disadvantaged children since the former learn early that letters are important and meaningful symbols; this, we believe, produced the difference in the relative difficulty of learning the two kinds of material. This may seem like a lot of inference for a little evidence, but that is the way preconceived notions work.

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